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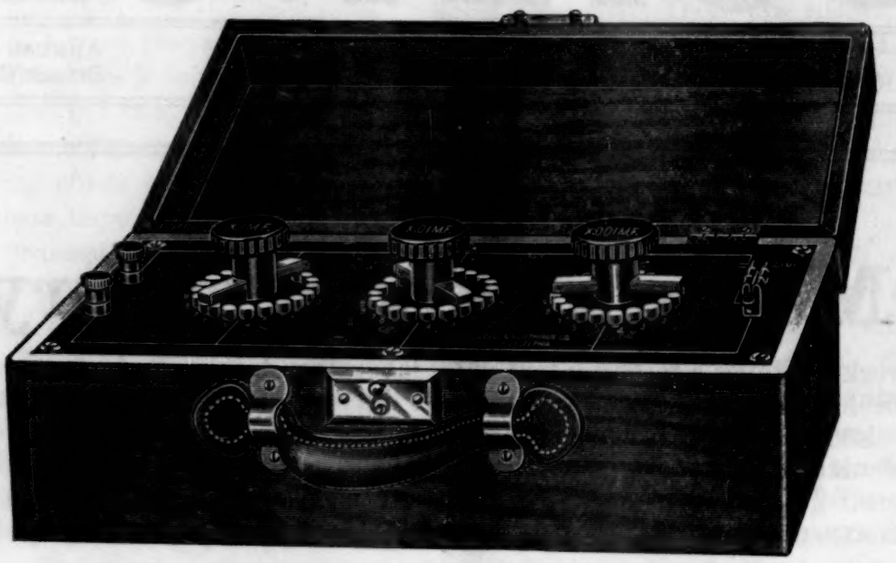

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VOL. LXII NOVEMBER 6, 1925 No. 1610

CONTENTS

Joseph Henry: DR. CHARLES D. WALCOTT 405

The Significance of Hexylresorcinol and its Homologues in Relation to the Problem of Internal Antisepsis: DR. VEADER LEONARD 408

Scientific Events:

English Support of Science; Program of the International Congress of Plant Sciences; Geological Conference in Western Texas; The Lane Medical Lectures at Stanford University; Selection of the Chief of the Chemistry Division of the U. S. Bureau of Standards 412

Scientific Notes and News 414

University and Educational Notes 417

Discussion and Correspondence:

Photography of Shadow Bands: PROFESSOR HARLAN TRUE STETSON. *Smithsonian Weather Forecasts:* DR. ALEXANDER MCADIE. *An Appeal for Simplified Literature Citations:* PROFESSOR E. D. MERRILL. *The Effect of Mineral Supplements on Reproduction of the Albino Rat:* W. D. SALMON. *The Hydroid of Craspedacusta Ryderi in Kentucky:* PROFESSOR FERNANDUS PAYNE 418

Scientific Books:

Merrill on the First One Hundred Years of American Geology: H. L. F. 421

Special Articles:

The Chemical Effects in Ionized Organic Gases: DR. S. C. LIND and DR. D. C. BARDWELL. *Morphological Changes in Bacterium Tumefaciens:* DR. MICHAEL LEVINE 422

Science News x

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JOSEPH HENRY[1]

JOSEPH HENRY was an international figure. The city of Albany, as his birthplace and the scene of his early discoveries, may rightfully assert a claim on Henry; Princeton, the site of his later triumphs in the study of electricity, justly claims a share of his renown; and Washington, where he devoted the last thirty years of his life to the organization and development of the scientific interests of the nation, has a deep sense of proprietorship in him. Yet, like all really great men, Henry belongs to the nation, and the nation has in many ways manifested her pride in his achievements. An impressive memorial service was held in his honor in 1878 in the United States House of Representatives. Five years later his monument in bronze was erected in the Smithsonian grounds by authority of Congress. Still later his statue was placed in the rotunda of the Library of Congress beside that of Newton, the two symbolizing scientific achievement of the highest order. And in 1924 a bust of Henry was placed in the Hall of Fame in New York City, thus according him a place among America's immortals. International recognition of his pioneer work was accorded him through the action of the International Congress of Electricians at Chicago in 1893, in adopting the name "henry" as the standard unit of inductive resistance.

In considering the life of this great American, we must remember that his half century of productive activity was divided into two distinct periods. The first included the two decades in which his brilliant researches in electro-magnetics brought him world-wide and permanent renown. The succeeding thirty years were devoted to a task for which he is not so well known to technicians, but which in the long run of years has proved to be of at least equal value to his epoch-making discoveries—the task of the organizer and administrator.

Henry's famous discoveries in the field of electro-magnetics, in the course of which he transformed the feeble and inefficient apparatus of Sturgeon into a powerful electromagnet capable of lifting a weight of 3,500 pounds, are perhaps too well known to need recounting. This remarkable advancement was due to his discovery of the necessary law of proportion between the electro-motive force in the battery and the resistance in the magnet, and his two distinct types of magnets, which he named the "intensity

[1] Address delivered on October 16 at the sixty-first convocation of the University of the State of New York.

magnet" and the "quantity magnet," ushered in a new epoch in electrical science.

While at first Henry devoted his efforts to studying the magnetizing effect of the electric current, his attention was later directed to the related electric phenomenon-induced electric currents. Even before Morse made use of the electro-magnet in telegraphy, this subject of induced currents had been experimented with by Henry both in Albany and at Princeton. Two fundamental and important properties of the electric current were announced by him as a result of these later researches—one, that the discharge of electricity from a Leyden jar was oscillatory, and the other, that these discharges could influence electrical apparatus located at a distance as great as two hundred feet without the aid of any connecting medium other than the ether, and this despite the interference of such non-conductors as floors and walls of buildings. He found also that when using lightning as his source of electric discharge, rather than the Leyden jar, his electrical apparatus was similarly affected, although in the latter experiment the distance was as much as eight miles. To Henry these observations were sufficiently significant to be recorded, and for hypotheses to be advanced concerning them. The science of electricity, however, had not advanced sufficiently at that time, nor at the time of his death, to make practical applications of these observations, but we know to-day that he had discovered a property of the ether which is essential to radio telegraphy and telephony. A distinguished president of the General Electric Company, upon this same occasion nine years ago, thus summed up the result of Henry's researches:[2] "I may say at once, without fear of successful contradiction, that the entire electrical industry is not only founded upon, but is a direct outgrowth of the work of Henry."

The second period of Henry's activity, covering the last thirty years of his life, represents the formative period of scientific effort in America, and during this critical time Joseph Henry was recognized as the leader in directing the national organization of science. In retrospect, the group of men that led in the development of scientific activities in America during this period were pioneers and outstanding figures in the history of science and education: Louis Agassiz, the naturalist; James Hall, geologist; James D. Dana, geologist and mineralogist; Silliman, chemist; Henry, the physicist; J. Lawrence Smith, chemist; Benjamin Pierce, the mathematician; Benjamin A. Gould, astronomer; Asa Gray, botanist; and many others of greater or less degree of productivity and influence. In this group Henry was the natural leader, with a vision that penetrated far into the future, and an initiative that led him to organize and administer effectively every trust placed in his charge. Men instinctively trusted and looked to him for suggestion and advice, and as we study his portrait this is readily understood. His face radiates intelligence, integrity and kindness, associated with great firmness and stability—qualities that led those about him to admire and accept his leadership.

In the year 1846, Henry came to the parting of the ways—it became necessary for him to make a momentous decision. The Smithsonian Institution had in that year been established by Act of Congress on the lines laid down by Henry, and the Board of Regents, having sought Henry's advice in planning the organization of the new institution, chose him as the first secretary, thus confirming his judgment as to the future development of the Smithsonian. His choice lay between a lifetime in the field which he loved and which held the most brilliant promise and the career of a scientific administrator in which there would be little opportunity for personal researches. Henry's greatness of soul is clearly shown in his cheerful willingness to abandon his own scientific career for the sake of providing opportunity for future researches and the diffusion of knowledge.

Having accepted the secretaryship of the Smithsonian, he entered at once upon the duties with his characteristic zeal and ability. The plan of organization which he drew up was a masterpiece of clear exposition, and the outline presented for the future operations of the institution was so fundamentally sound that it has not been necessary to change it in any essential point to the present day. He laid the foundations for the United States National Museum and the International Exchange Service of governmental and scientific publications, which have since become great national enterprises. He personally organized the great system of meteorological observations with its army of volunteer observers and its daily telegraphic reports, which formed the beginnings of the present United States Weather Bureau. He took a particular interest in the meteorological phase of the work of the institution, the "Instructions for Meteorological Observers" having been written by his own hand, the instruments used by the observers being tested by him, and in fact the entire administration of this extensive project being carried on by him personally. His aid and encouragement in the early surveys of the great west led eventually to the establishment of the United States Geological Survey and the Bureau of American Ethnology.

Joseph Henry's great success as a scientific admin-

[2] "The debt of electrical engineering to the work of Joseph Henry in Albany," by Dr. E. W. Rice, Jr. An address delivered at the fifty-second convocation of the University of the State of New York, October 20, 1916.

istrator came in large measure from his versatility and his broad viewpoint regarding matters of science. During his administration of the Smithsonian there arose the bitter controversies over the question of man's origin aroused by Darwin's announcement of his theory of evolution—a controversy which we have recently seen revived in this country. Henry believed that controversy was unfortunate and unprofitable, of little avail in settling a problem, and that the scientific method—through research to discover the facts and prove or disprove a contention by them—was the true means by which to arrive at the truth and a satisfying conclusion.

Professor Henry was a Scotch Presbyterian and a devoutly religious man, also qualified by tradition, training and mental ability to form an opinion as to whether there was a real conflict between the conceptions of the scientist and those of the religionist as to the processes of creation and the origin of man. In some reminiscences of Henry by Professor Henry C. Cameron[3] he quotes Henry as saying: "We explain a fact when we refer it to a law. We explain a law when we refer it to the will of God." Professor Cameron wrote that Henry could say, "There are two books from which I collected my divinity; besides that written one of God, another of his servant, nature—that universal and public manuscript that lies expansed unto the eyes of all"—also "that the person who thought that there could be any real conflict between science and religion must be very young in science or very ignorant of religion."

Professor Henry wrote very little on subjects outside of his special field of research and nothing has been found in print on his views of organic evolution, but he did talk freely with his associates, and one of them, Dr. W. B. Taylor, of the Smithsonian staff, states in his memorial of Henry:[4]

> From the very first, he accepted the problem as a purely philosophical one; employing that much abused term in no restricted sense. With no more reserve in the expression of his views, than the avoidance of unprofitable controversies (though no one—more than he—enjoyed the calm and purely intellectual discussion of an unsettled question by its real *experts*), he yet found no occasion to write upon the subject. The unpublished opinions, however, of one so wise and eminent, can not be a matter of indifference to the student of nature; and their exposition can not but assist to enlighten our estimate of the mental stature of the man, and of his breadth of apprehension and toleration.
>
> Whatever may be the ultimate fate of the theory of natural selection (he remarked in the freedom of oral intercourse with several naturalists), it at least marks an epoch—the first elevation of natural history (so-called) to the really scientific stage: it is based on induction, and correlates a large range of apparently disconnected observations, gathered from the regions of paleontology or geological successions of organisms, their geographical distribution, climatic adaptations and remarkable readjustments, their comparative anatomy, and even the occurrence of abnormal variations, and of rudimentary structures—seemingly so uselessly displayed as mere simulations of a "type." It forms a good (working hypothesis) for directing the investigations of the botanist and zoologist.[5] Natural selection indeed—no less than artificial (he was accustomed to say), is to a limited extent a fact of observation; and the practical question is to determine approximately its reach of application, and its sufficiency as an actual agency, to embrace larger series of organic changes lying beyond the scope of direct human experience. It is for the rising generation of conscientious zoologists and botanists to attack this problem, and to ascertain if practicable its limitations or modifications.

These broad and fearless views, entertained and expressed as early as 1860 or 1861, exhibiting neither the zealous confidence of the votary nor the jealous anxiety of the antagonist, received scarcely any modification during his subsequent years. Nor did it ever seem to occur to him that any reconstruction of his religious faith was involved in the solution of the problem. So much religious faith indeed was exercised by him in every scientific judgment that he regarded the teachings of science but as revelations of the divine mode of government in the natural world: to be diligently sought for and submissively accepted; with the constant recognition however of our human limitations and the relativity of human knowledge.[6]

From the very beginning of his connection with the Smithsonian, he emphasized the fact that Smithson, by the wording of his bequest, had intended the

[3] Smithsonian Misc. Coll., 356, 1881, p. 171.

[4] Smithsonian Misc. Coll., 356, 1881, pp. 342, 343.

[5] "In the investigation of nature, we provisionally adopt hypotheses as antecedent probabilities, which we seek to prove or disprove by subsequent observation and experiment; and it is in this way that science is most rapidly and securely advanced." (Agricult. Report, 1856, p. 456.)

[6] "With reference to the intimations of the comparative antiquity of man, Henry quoted with sympathetic approbation the sentiment so well expressed by the Bishop of London in a Lecture at Edinburgh, that 'the man of science should go on honestly, patiently, diffidently, observing and storing up his observations, and carrying his reasonings unflinchingly to their legitimate conclusions, convinced that it would be treason to the majesty at once of science and of religion, if he sought to help either by swerving over so little from the straight line of truth.' (Smithsonian Report for 1868, p. 33.)"

benefits from it to be not restricted to any locality or any country, but to be available to all mankind. Moreover, in Smithson's will, there was no restriction in favor of any particular branch of knowledge, and Henry insisted that all researches which had for their purpose the increase of existing knowledge should receive due consideration. This broad-minded policy resulted in keeping the activities of the institution well diversified, practically all the branches of science sharing in its attention, and this ideal has been followed to the present time.

Henry served without compensation as chairman of the Lighthouse Board of the United States from 1871 until the time of his death and in addition to administering the work of this important body in improving our national lighthouse system, he personally made a number of valuable researches in the field of fog-signalling and on the illuminants for use by lighthouses, with the result that great advances were made in methods of the protection of shipping. During the trying days of the Civil War, when every available agency was called into service for the preservation of the Union, Henry was one of a commission appointed by President Lincoln to examine and report upon various investigations and experiments intended to facilitate the operations of war and to improve the art of navigation. From the valuable results of this commission arose the National Academy of Sciences with its national charter, with Henry as one of the prime movers. He was its second president, and held that office until his death. He directed the mobilization of scientific effort during the Civil War and a half century later the National Academicians organized, under its charter, the National Research Council for the purpose of mobilizing the scientific and technical men for service to the government in its time of need. He also took a leading part in the organization of the American Association for the Advancement of Science and the Philosophical Society of Washington.

Who can estimate the influence of such a career upon the progress of science in America? Entering upon the field just as this country was beginning to take a serious part in the world's scientific advance, Henry did more than any other one man to shape the progress of this initial effort and direct it into channels which have resulted in placing America among the forefront of the nations in the march of science.

I have often thought, when in the rooms in the Smithsonian Institution where Henry lived and worked, of the wonderful progress of his beloved science since he passed on, fifty years ago. He made his first contributions to fundamental research in electro-magnetics, and then for the cause of the advancement of science undertook the organization and development of a scientific institution in accordance with a plan that was very largely if not wholly his own creation. With great singleness of purpose and a superb devotion to duty he gave all that was in him to the interests of science in America. A man of vision, initiative and power, modest, thorough and sincere, he won the respect not only of the scientific men of his time but also of the great leaders of political, social and educational thought. The founder of many of the present great governmental scientific agencies, adviser and counsellor in the formation of others and the leading spirit in the organization of many of the scientific societies of to-day, Henry may well be called the organizer of American science. This work alone entitled him to a place among America's immortals: add to it his brilliant researches and fundamental discoveries in the field of electricity, and we are led to say of Joseph Henry, with one of his biographers, "there is no greater name in American science."

CHARLES D. WALCOTT
SMITHSONIAN INSTITUTION

THE SIGNIFICANCE OF HEXYLRESORCINOL AND ITS HOMOLOGUES IN RELATION TO THE PROBLEM OF INTERNAL ANTISEPSIS[1]

BIOLOGICAL ASPECTS OF INTERNAL ANTISEPSIS

"CHEMOTHERAPY," in the sense of complete disinfection of the blood stream and tissues by means of some substance more toxic to any invading microorganism than to the host, is a conception which may be traced directly to Ehrlich's first efforts to divert the trend of medical thought from a more or less intelligent empiricism to the interpretation of biological processes and pharmacodynamic effects in terms of chemical reactivity.

It is unfortunate that a term so broad as this should have come to be generally employed in the very restricted sense of the treatment of specific general infections by chemical means. The administration of iron in anemia, or morphia to relieve pain, or even of sodium bicarbonate to relieve gastric hyperacidity are all examples of "chemotherapy" in the real meaning of the word, although in the latter in-

[1] From the Department of Bacteriology, School of Hygiene and Public Health, The Johns Hopkins University. Read before the symposium on "Chemistry in the field of micro-biology," at the annual meeting of the American Chemical Society, Baltimore, Maryland, April, 1925.

stance we do not require a working hypothesis to explain the results.

The term *systemic disinfection* can mean but one thing—the complete elimination of an infecting organism from the blood stream and tissues. But this designation is by no means broad enough to include all the various types of researches now grouped under the inclusive term "chemotherapy" and especially those relative to the treatment of bacterial infections. The writer has therefore employed the term *internal antisepsis* in this paper as designating the treatment of infections, either general or local, by means of the internal administration of chemical substances, whether parenterally or by mouth, and has substituted the term *systemic disinfection* as a more exact designation of the generally accepted meaning of the word "chemotherapy."

Ehrlich's conception that the pharmacodynamic activity of a given substance is due to fixation by or chemical reaction with the cell protoplasm led him to distinguish two varieties of biochemical affinity. To the property of ready fixation by the protoplasm of tissue cells he gave the term *organotropism* and designated by the term *parasitotropism* the property of fixation by the cell protoplasm of microorganisms. The question at once presents itself: Might it not be possible by a study of these properties, as exhibited by various substances of known chemical constitution, to evolve some stable complex so highly parasitotropic and at the same time so slightly organotropic as to accomplish complete disinfection of the blood stream and tissues at one stroke (*Therapia sterilians magna*) or, failing this, a substance showing at least a large ratio between the smallest curative dose and the largest non-toxic dose (Therapeutic index)?

Unfortunately, efforts to discover such a substance have been so uniformly disappointing as to discourage the hope of developing any drug (whose parasitotropic action *in vivo* is not highly specific) which could, in the strict sense of the term, be considered a systemic disinfectant. Although Ehrlich and Bechhold were able to increase very greatly the bactericidal power (parasitotropism) of various phenolic substances, this was usually accompanied by an equivalent increase in toxicity (organotropism). In no instance, either in Ehrlich's work or in the many researches which have followed it, has it been found possible to introduce into any substance a non-specific *parasitotropic surplus* definitely attributable to chemical constitution and sufficiently pronounced to offer real encouragement.

Were we dealing with but two types of protoplasm, that of the parasite and that of the host, the problem of systemic disinfection might be a simple one, for we know that very slight differences in chemical constitution may result in profoundly dissimilar biochemical reactions. It becomes very complicated, not so much because of the fact that bacterial species may differ rather widely among themselves, but more especially because in the higher animal we are confronted not only with a large number of highly differentiated types of protoplasm which react differently to the same drug or chemical, but also with the probability that a substance introduced into the body will itself undergo a number of chemical changes. To this latter fact, indeed, we may attribute every important experimental and therapeutic advance which has been made in this field. The specific parasitotropic action of substances such as salvarsan, tryparsamide, atoxyl, Bayer 205, trypan red, the compounds of bismuth and antimony and even of quinine and emetine, can not be explained on the basis of any direct toxic action on the parasite which we can demonstrate, for none of them will injure it in the test tube in dilutions even remotely approaching those which are attainable in the blood stream and tissues. Whatever the mechanism by which the intense parasitotropic action of these drugs is produced in the body, it is necessary, on the basis of our present knowledge, to assume that they possess tissue affinities which are indispensable to their therapeutic action.

Comparing the complex biochemistry of the higher animal as a unit with the relatively simple metabolic processes of a unicellular organism, it seems quite reasonable that we should know of a great many violently toxic substances which possess no bactericidal properties, but, as yet of not a single non-specific bactericidal substance which can be said to be devoid of toxicity even in the clinical rather than in the strict physiological interpretation of the term. It is quite possible that, inherent in the fundamental chemical characteristics of protoplasm in general, there may be some definite and essential structural complex which precludes the possibility of a toxic action by any substance on bacteria and not on other types of protoplasm. We know that a great many species of microorganisms are extremely vulnerable to highly specific substances such as the various immune substances which are formed in the body. Furthermore, we know through the work of Churchman with gentian violet that a toxic action, specific not to individual species but to very large groups of microorganisms, readily distinguishable by microchemical means (the Gram stain), is possible. The Gram stain itself is sufficient proof of the existence of a particular chemical characteristic common to large groups of widely different unicellular forms. In their comparative simplicity lies the suggestion that unicellular organisms, as a whole, or at least certain groups of

them, may share some common characteristic essential to the chemistry of their life processes, which might be dissimilar to anything occurring in any of the tissues to the higher animals. The idea of systemic disinfection by chemical means is necessarily based upon the hope that some such difference exists, whether it be common to all bacteria, to large or small groups, or merely to definite species, and is supported by the possibility that such a difference might be utilized to our advantage without any accurate knowledge of its chemical nature.

At least one chemist has had the imagination and courage to strike at the very roots of this whole problem. I refer to the recent work of Treat B. Johnson, of Yale University, on the chemical composition of the bacterial cell. While at first glimpse the very boldness of this attack might seem to invite defeat, it must be remembered that we already have an excellent general knowledge of the decomposition products of various types of protoplasm and that work of this nature may well result in the identification of some relatively simple structural characteristic common to the protoplasm of certain types of pathogenic microorganisms and essential to their life processes. It might become possible, with this knowledge, not only to interpret such biochemical phenomena as disinfection, bacteriostasis, vital staining, etc., in terms of more or less definite chemical reactions, but might also point the way to the synthesis of new substances possessing a selective toxic action on the parasite.

Owing to the enormous complexity of the problem as a whole, the search for an internal antiseptic has followed two subsidiary methods of attack, both of which have sprung from Ehrlich's original conception of the ideal, and must be regarded as compromises with that ideal made necessary by the exigencies of the problem. These have been characterized respectively by

(1) Attempts to reduce the unfavorable effect on the tissues of the host of substances which, administered internally, are known to exhibit a high degree of specific toxic action towards the particular organism responsible for certain diseases.
(2) Attempts to impart active and non-specific bactericidal or bacteriostatic action to relatively non-toxic substances known to possess the property of rapid concentration in certain tissues or rapid elimination into certain body fluids.

The arsphenamines remain our best example of researches of the first type, the starting point being the powerful but highly specific parasitotropic action displayed *in vivo* by a substance of known chemical constitution (atoxyl); the goal being the reduction or elimination of its toxic action on the host in its derivatives or compounds without interference with its parasitotropic properties.

The work of Paul Lewis with the trypan dyes, some of which possess the remarkable property of penetrating the tubercle and staining its caseous contents when injected into the circulation of tuberculous animals, and that of Davis, White and their coworkers, with a large number of dyes of the xanthone and sulphonephthalein types which are eliminated in the urine with astonishing rapidity and completeness, are both characteristic of researches of the second type. The starting point is a relatively non-toxic substance of known chemical constitution which is possessed of the property of rapid concentration in certain issues or body fluids; the goal is the development or enhancement of bacteriostatic or bactericidal action in its derivatives or compounds without destroying its tissue or secretory affinities. Researches of this type have been concerned almost exclusively with dyes for the reason that their physiological affinities may be readily observed.

Neither of these methods aim at the ideal, but taken together they may be expected to narrow down the general problem appreciably and with the possibility always at hand that some chance observation may point the way to a more general solution.

Both are beset with difficulties.

Chief among these is the fact that test tube experiments offer little if any indication of the possible therapeutic usefulness of a given substance as a systemic disinfectant. Thus, Ehrlich abandoned atoxyl in 1903 because it would not kill the trypanosome in the test tube. It was only after Thomas and Breinl (1905) proved its effectiveness in experimental trypanosomiasis that Ehrlich returned to it as the starting point of the researches which led to the production of arsphenamine. In the present state of our knowledge we are not only forced to adopt the wasteful method of trial and discard, but even in this must employ the actual therapeutic experiment as the only trustworthy source of information.

The second method of attack is necessarily limited in its scope by the very specific physiological properties which form the basis of each starting point. Although it offers a wider opportunity for ruling out large numbers of compounds by simple physiological and bacteriological experiments rather than by actual therapeutic trial, there are a number of drawbacks which greatly increase the difficulties.

In the first place most antiseptics and germicides become inert or suffer marked deterioration of their active properties in solution in such fluids as blood serum, urine, etc., or even in the presence of rela-

tively small amounts of organic matter. The germicides of the chloramin type, of which so much was formerly expected, are excellent examples of this imperfectly understood interfering action. On the other hand, substances which retain at least a portion of their bacteriostatic or bactericidal properties in solution in biologic fluids are very likely to be destroyed in the body or rendered inert by conjugation.

Finally, antiseptics and germicides which retain their activity in biologic fluids seem to lose the special physiological affinities characteristic of similar substances which are either without any antibacterial action whatever or which lose it in solution in biologic fluids. As an example, Davis found in his elaborate search for an internal urinary antiseptic that among the hundreds of compounds he examined those which were rapidly excreted into the urine invariably lost their bactericidal action in solution in this fluid, while those substances which retained their bactericidal properties in urine were not excreted by the kidney, in spite of the fact that in many instances they were closely analogous compounds and might have been expected from their chemical constitution to possess a considerable degree of renal affinity.

ALKYL RESORCINOLS

The investigations which have led recently to the synthesis of hexylresorcinol and its application as an internal urinary antiseptic were begun some twelve years ago. At that time the lower homologues of this series of alkyl resorcinols, synthesized by Treat B. Johnson, of Yale University, and subjected to a biological examination by Leo F. Rettger and myself, were found to possess not only a very high degree of bactericidal power, but were found also to be relatively non-toxic substances. The examination of propyl resorcinol, which I found to be excreted in the urine quite promptly after oral administration to rabbits, and a comparison of its biologic properties with those of resorcinol and ethyl resorcinol, led to the hypothesis that alkylation of resorcinol increases its bactericidal power and decreases its toxicity in direct proportion to the sum of the atomic weights of the atoms in the alkyl chain. Application of this idea, however, to practically every available phenolic nucleus, other than resorcinol, with the object of developing a very powerful germicide of minimum toxicity, led to indifferent or negative results.

A study of the higher members of the resorcinol series which had never been made seemed to be desirable for the reason that they held some promise of usefulness in the field of urinary antisepsis, owing to the rapid elimination of the lower members of the urine. Through the cooperation of Dr. A. R. L. Dohme, who generously diverted the activities of his chemical research organization to a furtherance of this research, and through the splendid technical work of Dr. Edward H. Cox, Dr. Daniel Twiss and Dr. Ellis Miller rapid progress was made. The entire series was synthesized and each product, including the intermediate ketones, obtained in pure crystalline form—a chemical feat necessitating the solution of a great many serious difficulties.

A biological examination of these compounds led to astonishing results. Each increase in the weight of the alkyl chain resulted in a remarkable increase in bactericidal power and this with at least no apparent increase in toxicity when administered to rabbits by stomach tube. The peak of bactericidal power was reached in hexylresorcinol, which, with a phenol coefficient variously estimated at from 46 to 56.3 by the United States Hygienic Laboratory method now in use, is probably the most powerful phenolic germicide ever described. In spite of this, however, daily administration by mouth of doses of 0.5 gm to rabbits for twenty-one consecutive days, and single doses as large as 2.5 gm (1.0 per Kilo) resulted in no immediate or remote toxic effects which could be detected either by renal function tests, urine and blood examinations during the period of observation or later, by microscopic examination of stained sections of all the more important organs. In fact, most of the animals saved for late observation after prolonged courses of hexylresorcinol showed remarkable gains in weight.

The details of the experimental work with hexylresorcinol in the test tube, in rabbits and in normal men have been published elsewhere and will not be repeated at this time. Suffice it to say that by a technic closely similar to that employed by Davis the administration of hexylresorcinol to normal men in doses of from 0.3 to 0.6 gm three times a day was found to result in the secretion of a practically continuous flow of bactericidal urine which, in the test tube, was found to be capable of destroying strains of *B. coli* as well as *Staphylococcus albus* and *aureus* isolated from cases of active pyelitis. In both rabbits and normal men hexylresorcinol was found to answer Davis's qualifications for an ideal internal urinary antiseptic in the following manner:

Hexylresorcinol was found to be:

(1) Chemically stable.
(2) Non-toxic in highly effective doses.
(3) Non-irritating to the urinary tract.
(4) Bactericidal (not merely bacteriostatic) in high dilution in urine of any reaction.

(5) Eliminated in high percentage by the kidney, largely as an inert conjugate, but unchanged in sufficient amount to impart definite bactericidal properties to the urine.

These theoretical requirements were known and clearly stated years before any substance possessing them was known. Hexylresorcinol is the only substance ever described which has been proved to meet them.

To these qualifications must be added the advantage of the feasibility of prolonged administration of hexylresorcinol by mouth in repeated doses and the clinical possibility of a continuous rather than an intermittent action in the urinary tract.

During the past year the results of this work have been applied clinically by myself and by a number of physicians in the larger medical centers through the administration of hexylresorcinol in the treatment of infections of the urinary tract. The results have been extremely satisfactory. Many cases of pyelitis and cystitis which have resisted for years all known forms of treatment have yielded promptly and completely without any other treatment than hexylresorcinol by mouth. On the other hand, no untoward effects of the drug have been observed in an experience now exceeding five hundred cases.

In summary, hexylresorcinol is by far the most powerful germicide ever described as possessing anything like its degree of non-toxicity to animals and to man. It has been developed and applied as an internal urinary antiseptic by a logical and orderly application of the chemical and biological characteristics of its lower homologues and exemplifies a method by which specific problems in internal antisepsis may be gradually narrowed down through the enhancement of desirable biological properties definitely attributable to chemical constitution.

VEADER LEONARD

THE JOHNS HOPKINS UNIVERSITY,
BALTIMORE, MARYLAND

SCIENTIFIC EVENTS

ENGLISH SUPPORT OF SCIENCE

THE report for 1924–25 of the British Committee of the Privy Council for Scientific and Industrial Research has just been published. It shows an active campaign in England, chiefly supported by the government, for the development of scientific research and the applications of science in English industrial work.

As is well known, the larger part of the funds provided the council by the government are used to assist industrial associations to develop useful scientific studies pertaining to their special interests. During the academic year 1924–25, however, 258 grants were made to research workers and students-in-training involving total expenditure estimated at £35,000, compared with £40,820 in 1923–24.

The expenditure on headquarters administration during the financial year 1924–25 was £35,920, and the total expenditure of the department was £539,199. This sum was made up of £311,286 from the exchequer, £38,669 from the interest of the million fund, £100,118 from the capital of the fund, and £89,126 from fees for tests and special investigations for outside bodies, from contributions towards research funds for the Froude tank, alloys of iron and bridge stresses researches and from repayment by the service departments.

VERNON KELLOGG

NATIONAL RESEARCH COUNCIL

PROGRAM OF THE INTERNATIONAL CONGRESS OF PLANT SCIENCES

THE International Congress of Plant Sciences (Fourth International Botanical Congress) will be held in Ithaca, New York, from August 16 to 23, 1926. As has been announced[1] by the organizing committee (B. M. Duggar, *chairman;* H. C. Cowles, *secretary;* H. H. Whetzel, *local arrangements*) "the work of the congress shall be primarily with problems of fundamental research and teaching." Although the congress is not to provide an occasion for legislation on regulatory matters of international significance, the organizing committee has expressly provided that "adequate opportunity shall be accorded all sections for the discussion of regulatory recommendations of international significance."

Except for some sessions of the congress as a whole for addresses of general interest and for the transaction of certain business, the program of the congress will be conducted by sections, the organization of the programs for each section being in charge of a secretary, who will also be secretary of the section during the congress. The sections thus far authorized by the organizing committee, and the corresponding secretaries, are the following:

Agronomy—C. H. Myers, Cornell University, Ithaca, N. Y.

Bacteriology—J. M. Sherman, Cornell University, Ithaca, N. Y.

Cytology—L. W. Sharp, Cornell University, Ithaca, N. Y.

Morphology, Histology and Paleobotany—D. S. Johnson, Johns Hopkins University, Baltimore, Md.

Ecology—H. L. Shantz, Bureau of Plant Industry, Washington, D. C.

[1] SCIENCE, LXI: 58–59. 1925.

Forestry—R. S. Hosmer, Cornell University, Ithaca, N. Y.

Genetics—C. E. Allen, University of Wisconsin, Madison, Wis.

Horticulture—A. J. Heinicke, Cornell University, Ithaca, N. Y.

Physiology—O. F. Curtis, Cornell University, Ithaca, N. Y.

Pathology—Donald Reddick, Cornell University, Ithaca, N. Y.

Pharmacognosy and Pharmaceutical Botany—H. W. Youngken, Massachusetts College of Pharmacy, Boston, Mass.

Taxonomy—The name of secretary will be announced later.

Mycology—H. M. Fitzpatrick, Cornell University, Ithaca, N. Y.

The secretaries of the sections have been appointed by the national societies or sections of societies with corresponding interests. In many instances the societies or sections of societies have selected as secretary a resident of Ithaca to facilitate cooperation in the matter of local arrangements, etc. Shaping the programs of the sections is in every case a matter of consultation of the secretaries with their respective colleagues. General program arrangements are in the hands of a program committee (J. R. Schramm, *chairman;* L. W. Sharp, *secretary;* secretaries of the sections, cooperating).

Participation in the formal programs will be by invitation. Every effort will be made to secure, on an objective scientific basis without reference to geographical location, the outstanding active leaders in fundamental research and teaching in the respective fields.

In addition to the formal programs there will be time available in each section for round tables, scheduled either in advance or upon decision of the individual sections after the congress convenes. Gatherings of this type will afford opportunity for a wider participation of plant biologists in the sectional activities. Also, ample facilities are being arranged for non-commercial exhibits, providing another effective medium for individual participation in the scientific activities of the congress.

The plans for the congress further provide for excursions, collecting trips, inspection tours to local and nearby experimental work in progress, etc.

Communications regarding the congress should be addressed as follows:

(1) Concerning round tables and other strictly sectional matters—to the appropriate sectional secretary.

(2) Concerning exhibits and general program matters—to the undersigned.

(3) Concerning excursions, collecting trips, inspection tours, local arrangements, transportation, etc.—H. H. Whetzel, Cornell University, Ithaca, N. Y.

(4) Concerning the congress in general—B. M. Duggar, Missouri Botanical Garden, St. Louis, Mo.

L. W. SHARP,
Secretary Program Committee
STONE HALL, CORNELL UNIVERSITY,
ITHACA, N. Y.

GEOLOGICAL CONFERENCE IN WESTERN TEXAS

DURING the week of October 19 to 24 a field conference was held in western Texas for the purpose of working out various problems of the upper Permian red beds. The main object of the conference was to correlate certain members of the Double Mountain formation of Texas with known ledges in Kansas and Oklahoma. Those attending the conference were E. H. Sellards, director of the Bureau of Economic Geology of Texas; Chas. N. Gould, director of the Oklahoma Geological Survey; J. W. Beede, an authority on the American Permian, and the following geologists, the greater number of whom are connected with oil companies:

C. L. Cooper, R. L. Clifton, C. W. Tomlinson, W. A. Riney, J. V. Howell, L. E. Trout, F. K. Foster, Wallace E. Thompson, M. M. Garrett, T. Davis, R. T. McNalley, U. B. Hughes, J. P. Bowen, John A. Kay, Archie R. Kautz, Louis Franklin, W. M. Nolte, C. W. Clark, D. J. Wolff, T. F. Newman, A. V. Jones, P. A. Meyers, F. E. Russell, Lester Luecke.

The results of the observations may be summarized as follows:

The general stratigraphic units of the upper Permian red beds are continuous in Kansas, Oklahoma and Texas. The gypsum-bearing formations are more pronounced in Texas than in states to the north.

The Double Mountain formation of Texas includes the following formations in Oklahoma (oldest beds named first): Duncan, Chickasha, Blaine, Dog Creek, Whitehorse, Day Creek, Cloud Chief and Quartermaster.

One formation, the Blaine, and probably others also, may be traced continuously from southern Kansas across Oklahoma as far as the vicinity of San Angelo on the Concho River, west central Texas. The outcrop of the Blaine in the three states approximates 600 miles.

THE LANE MEDICAL LECTURES AT STANFORD UNIVERSITY

THE twentieth course of Lane Medical Lectures will be delivered by Dr. Vittorio Putti, November 9, 10,

11, 12 and 13, in Lane Hall at the Stanford University Medical School in San Francisco.

The Lane Medical Lectures were founded in 1896 by the late Dr. Levi Cooper Lane. They consist of a free course of lectures on medical subjects by men distinguished at home or abroad for their work in either medicine or surgery, and are intended for medical students and the medical profession at large.

The lecture on November 13 will be on "The University of Bologna in the history of medicine." Dr. Putti, who will give the lecture series, is professor of orthopedic surgery at the University of Bologna and director of the Rizzoli Institute of Bologna, Italy.

The previous lectures have been given by Dr. Simon Flexner, director of the laboratories at the Rockefeller Institute for Medical Research, who in 1917 discussed the "Physical basis and present status of specific serum and drug therapy"; Alonzo Englebert Taylor, professor of physiological chemistry at the University of Pennsylvania, who in 1919 spoke on "The feeding of the nations at war." In 1921 the late L. Emmett Holt, of Columbia University, discussed "Growth and nutrition," and last year Dr. Ludwig Aschoff, professor of pathology, University of Freiburg, Germany, delivered the lecture series on "Selected topics in pathology."

SELECTION OF THE CHIEF OF CHEMISTRY DIVISION OF U. S. BUREAU OF STANDARDS

THE United States Civil Service Commission states that the position of chief of the chemistry division of the Bureau of Standards of the Department of Commerce is vacant, and that, in view of the importance of the position in the whole field of chemical research, and to insure the appointment of a thoroughly qualified man for the work, an unusual method of competition will be followed to fill the vacancy. Instead of the usual form of civil service examination, the qualifications of candidates will be passed upon by a special board of examiners composed of Dr. George K. Burgess, director of the Bureau of Standards; Dr. F. G. Cottrell, director of the Fixed Nitrogen Research Laboratory of the Department of Agriculture; Dr. W. A. Noyes, dean of chemistry of the University of Illinois; Dr. W. R. Whitney, chief of the research laboratory of the General Electric Company, and Mr. Frederick W. Brown, examiner of the United States Civil Service Commission. For the purposes of this examination all these men will be examiners of the Civil Service Commission.

The examination will consist solely of a consideration of qualifications by this special board. The minimum qualifications for consideration are a doctor's degree in chemistry from a college or university of recognized standing, and at least ten years' experience in the direction and performance of chemical research of a character to show the required degree of chemical knowledge and ability, executive capacity of the highest order, thorough familiarity with chemical literature and scientific maturity.

The duties of the position are to act as the scientific and administrative head of the chemistry division of the Bureau of Standards; to determine and execute the policies of the bureau relating to work in chemistry; to be responsible for the maintenance and operation of the division; to direct or to perform research in the field of chemistry, and to prepare reports and data for publication. These duties involve high administrative responsibility, contact with the chemical industry and with the technical experts in the field of chemistry and particularly the ability to plan, direct and coordinate research, investigation and testing of the most advanced character. The opportunities for research and development are practically unlimited, and the laboratory equipment and other facilities are unexcelled.

The entrance salary for this position is $5,200 a year. Promotion may be made without change in assignment up to $6,000 a year. The present director of the Bureau of Standards was advanced through promotion from the $6,000 grade.

Qualified persons who wish to be considered for this vacancy should apply to the United States Civil Service Commission, Washington, D. C., for form 2118, which must be executed and returned, with a list of the applicant's technical publications and reprints of such of these publications as are available, to the office of the Civil Service Commission at Washington not later than Saturday, December 5.

SCIENTIFIC NOTES AND NEWS

DR. CHARLES D. WALCOTT, secretary of the Smithsonian Institution, received the honorary degree of doctor of laws at the annual convocation exercises of the University of the State of New York on October 16. On this occasion Dr. Walcott gave an address on Joseph Henry, which is printed in this issue of SCIENCE.

DR. J. B. WHITEHEAD, professor of electrical engineering and dean of the faculty of engineering of the Johns Hopkins University, Baltimore, has been awarded the triennial prize, for the year 1925, of the Fondation George Montefiore of Liége, Belgium, for the best original work contributing to scientific advancement in the technical applications of electricity. The prize is awarded for his series of papers entitled "Gaseous ionization in built-up insulation." The

amount of the prize this year is 4,000 francs. This is the second time that Dr. Whitehead has been awarded this prize.

THE Morris Liebmann Memorial Prize for this year, one of the two annual awards made by the Institute of Radio Engineers, has been awarded to Frank Conrad, of the Westinghouse Electric and Manufacturing Company, in recognition of his research work in the transmitting and receiving of short-wave length wireless.

LIEUTENANT-COMMANDER E. E. WILSON, of the Bureau of Aeronautics of the Navy Department, Washington, D. C., has been awarded a prize of one hundred dollars by the American Society of Mechanical Engineers for his paper on "Power plants for U. S. Navy aircraft," printed in the October issue of *Mechanical Engineering*.

THE Baly medal of the Royal College of Physicians, given for distinguished work in physiology, chiefly during the past two years, was presented on October 19 to Professor R. Magnus, professor of pharmacognosy in the University of Utrecht.

AT the fifth Congress of Industrial Chemistry, organized by the French Society of Chemical Industry, and recently held in Paris, a Chevreul medal was awarded to Professor Henry E. Armstrong, and Sir Robert Hadfield was elected an honorary member of the society.

THE Philippine delegates to the sixth congress of the Far Eastern Association of Tropical Medicine at Tokio, Japan, October 12 to 31, were Major Arthur P. Hitchens, Army Research Board; Drs. I. Oto Schobl, Bureau of Science; Agerico B. M. Sison, of the College of Medicine, and Leoncio Lopez-Rizal and Cristobal Manalang, both of the Philippine Health Service.

DR. MARSTON TAYLOR BOGERT, professor of organic chemistry at Columbia University, has been appointed a member of the advisory board for the bureau of criminal science, Police Department, City of New York.

SCOTT TURNER, a mining engineer of Lansing, Mich., has been appointed director of the U. S. Bureau of Mines to succeed Dr. H. Foster Bain, who resigned after the recent transfer of the bureau from the Department of the Interior to the Commerce Department.

DR. W. E. BRITTON, Connecticut state entomologist, has been appointed to succeed the late Dr. Henry Hollister Robinson as superintendent of the Connecticut Geological and Natural History Survey and will carry on the work in connection with his duties as state entomologist.

PROFESSOR WALTER G. WHITMAN, assistant professor of chemical engineering and assistant director of the research laboratory of applied chemistry at the Massachusetts Institute of Technology, has resigned to join the development department in the research laboratory of the Standard Oil Company of Indiana.

DR. SOLON SHEDD, professor of geology at Washington State College, has been appointed curator of the Branner Geological Library at Stanford University.

DR. G. PHILIP GRABFIELD, instructor of pharmacology in the Harvard Medical School, has been appointed medical director of the Boston branch of the Life Extension Institute.

DR. J. L. MCELROY, director of St. Mark's Hospital, New York City, has been appointed head of the University of Iowa Hospital.

W. F. PATE, agronomist of the North Carolina Agricultural Experiment Station, has been appointed to the staff of the soil improvement committee of the National Fertilizer Association, and is in charge of an office of the committee, recently established at Raleigh, N. C. Professor Ward H. Sachs, who has been connected with the agronomy division of the University of Arkansas, has joined the Atlanta, Ga., branch.

S. K. ALLISON and G. S. Tunell, graduate students at Harvard University, and C. S. Piggot, formerly with the research laboratory of the U. S. Industrial Alcohol Co., have joined the staff of the Geophysical Laboratory, Carnegie Institution of Washington.

DR. W. W. COBLENTZ, of the United States Bureau of Standards, and Dr. H. T. Stetson, assistant professor of astronomy at Harvard University, are sailing from San Francisco on November 7 for Sumatra, where they are going for the purpose of making a study of the heat radiation of the solar corona during the total eclipse of the sun on January 14.

DR. E. M. CHAMOT, professor of sanitary chemistry at Cornell University, has returned from an extended mission abroad, where he represented a group of seven universities—including Harvard, Yale, Columbia, Massachusetts Institute of Technology, University of Pennsylvania, the Johns Hopkins and Cornell. Professor Chamot's mission in France was to foster cooperation between American and French universities, and to place before the students in that country the advantages to be gained from graduate study in the United States.

DR. G. E. HARMON, of the department of hygiene and bacteriology of the school of medicine of Western Reserve University, is spending his sabbatical year (1925–1926) in study with Professor Karl Pearson at the biometric laboratory, University College, London.

DR. S. PHILIP GOODHART, professor of clinical neurology at Columbia University, has gone abroad where he is showing his slow-motion moving-picture analysis of nervous diseases. He is giving lectures and exhibits in Vienna, Paris and London.

DR. WALLER S. LEATHERS, of the department of preventive medicine at Vanderbilt University, recently spent some months in Great Britain observing methods of health teaching and administration. Since his return, Dr. Leathers has been notified of his election as a fellow of the Society of Medical Officers of Health, which has been the representative body of the British Public Health Service since its foundation in 1856.

DR. C. D. MARX, emeritus professor of civil engineering at Stanford University, has gone to Germany for the purpose of representing Stanford University and the American Society of Engineers at the centenary of the Karlsruhe Polytechnic Institute of which he is a graduate. He expects to return to Palo Alto in November.

NEIL M. JUDD, curator of American archeology, United States National Museum, has returned to Washington following completion of his fifth season as director of the National Geographic Society's Pueblo Bonito Expedition. These explorations, pursued in northwestern New Mexico, have shed new light upon the prehistoric peoples of the southwestern United States. Most outstanding of the past season's accomplishments are the definite establishment of a pottery sequence for the unnumbered centuries during which Pueblo Bonito was inhabited and the partial exposure of a foundation series, underlying the eastern half of the great ruin and extending 500 feet beyond its outer wall.

DR. GEO. D. SHEPARDSON, head of the department of electrical engineering at the University of Minnesota, has been granted a sabbatical furlough for the year 1925–26, which will be spent largely in foreign travel. During his absence, Professor F. W. Springer will be acting head of the department.

DR. HOWARD M. ELSEY, associate professor of physical chemistry at the University of Kansas, has been granted a year's leave of absence for work in the research laboratories of the Westinghouse Electric Company at Pittsburgh. During his absence the major portion of his work at the University of Kansas has been taken over by Dr. Robert Taft.

PROFESSOR SIDNEY DEAN TOWNLEY, of the department of applied mathematics at Stanford University, has been granted a leave of absence and is working in the Stetson Astronomical Laboratory at Harvard University, where he is giving courses in astronomy.

DR. OSKAR VON MILLER, head of the Deutsches Museum of Munich, has been traveling through Mexico and arrived in the United States on October 28. Meetings in his honor have been planned for mid-November in both New York and Chicago.

AT the Massachusetts Institute of Technology, Dr. H. Muller, formerly an assistant to Professor Paul Debye, of Zurich, who lectured at the institute last year, has joined the staff of the department of physics as a special lecturer in physical chemistry. Beginning in November, Professor Max Born, of Göttingen, Germany, will lecture until the end of the first term. During the spring term, Professor Th. de Donder, of Brussels, will lecture on "The theory of relativity" and "The mathematical theory of electricity."

DR. GEORGE E. VINCENT, of the Rockefeller Foundation, will give the anniversary discourse on "The doctor and the changing order" at the seventy-ninth anniversary meeting of the New York Academy of Medicine on November 19.

PROFESSOR WALTER B. CANNON, of the Harvard Medical School, gave a lecture on October 16 under the auspices of the Sigma Xi Club at the University of Buffalo on "Some recent revelations by the denervated heart."

SAMUEL E. DIBBLE, president of the American Society of Heating and Ventilating Engineers and professor and head of the department of heating, ventilating and sanitation at the Carnegie Institute of Technology in Pittsburgh, was the speaker at a meeting of the Boston chapter of the society on October 27.

A MEETING in memory of Dr. Chas. F. Chandler, one of the founders of the American Chemical Society, in which all his friends will participate, will be held in Havemeyer Hall, Columbia University, on Monday evening, November 16, at 8:30 P. M. The principal speakers of the occasion will be the Honorable Elihu Root and Professor M. I. Pupin.

SIR CHARLES SHERRINGTON, president of the Royal Society, unveiled on October 19 the bronze memorial tablet to Sir Charles Wheatstone which has been placed in St. Michael's Church, Gloucester, by the city authorities. The ceremony marked the fiftieth anniversary of the death of Wheatstone, the pioneer of the electric telegraph.

DR. HENRY JACKSON WATERS, president of the Kansas State Agricultural College from 1909 to 1917 and known for his work on animal nutrition, died on October 26, aged sixty years.

DR. W. D. HUNTER, senior entomologist in charge of southern field crop insect investigations, U. S. Bu-

reau of Entomology, and a member of the Federal Horticultural Board, died on October 13.

DR. JUAN GUITERAS, professor of pathology and tropical medicine at Havana and formerly of the University of Pennsylvania, known for his work on yellow fever, died on October 28 at the age of seventy-three years.

DR. ANDREW GRAY, F.R.S., emeritus professor of natural philosophy in the University of Glasgow, died on October 10 at the age of seventy-eight years.

J. Y. BUCHANAN, F.R.S., chemist and physicist to the *Challenger* expedition and vice-president of the Conseil de Perfectionnement de l'Institut océanographique de Paris, died on October 16, aged eighty-one years.

DR. A. RICHAUD, professor of pharmacology at the University of Paris, has died, aged sixty years.

A CORRESPONDENT writes that Dr. Earle Jay Babcock, dean of the college of engineering of the University of North Dakota, whose death on September 3 has been announced in SCIENCE, was born June 11, 1865, at St. Charles, Minnesota, graduated from the University of Minnesota in 1889 and began work at once as a member of the faculty of the University of North Dakota. His department at first was chemistry and geology, which changed with the growth of the institution until now it is industrial chemistry, mining and metallurgy. Dr. Babcock was the first state geologist of North Dakota, from 1897 to 1902, and was acting-president of the university in 1917–18. His researches and investigations for the development of the natural resources of the state were in many different lines of chemistry and geology, but were particularly extensive in the study and research for methods of manufacture or use of natural cements, lignite coals and pottery clays.

THE forty-third annual meeting of the American Ornithologists' Union will be held in New York City from November 9 to 12. The sessions will be held in the American Museum of Natural History, 77th Street and Central Park West, and the headquarters will be at the Sherman Square Hotel, Broadway and 70th Street. Monday will be devoted to business meetings and at 8 P. M. there will be a business session for the election of officers and members. The three following days will be devoted to the presentation and discussion of scientific papers. In connection with the meetings there will be an exhibition of bird paintings at the museum, showing the work of American artists, and on Friday, following the regular sessions, an excursion to the New York Zoological Park, 185th Street and Southern Boulevard. The union now has a membership of about 1,700, including more than 100 foreign members distributed in various parts of the world.

THE following public lectures will be given on Saturday afternoons at 3:30 in the museum building of the New York Botanical Garden: November 7, "Beautiful gardens of New York State," Mrs. John W. Paris; November 14, "Seeds as carriers of disease," Dr. C. R. Orton; November 21, "Original exploration of the Yellowstone National Park," Professor John M. Coulter; November 28, "Botanical features of Ceylon," Dr. H. A. Gleason.

UNIVERSITY AND EDUCATIONAL NOTES

AN anonymous gift of $75,000, to be used in annual divisions of $15,000, for increasing the teaching staff in the departments of physics and of electrical engineering, has been received by the Massachusetts Institute of Technology.

THE trustees of Union College have voted to spend $50,000 on enlarging the physics laboratory. Ludlow Melius, of New York, has given the college funds to erect a greenhouse for the department of botany.

ON October 21 the science building of the University of Richmond was completely destroyed by fire. All the apparatus and material used for laboratory work in physics, chemistry, biology and botany was lost. The biology and chemistry libraries were burned together with much irreplaceable material.

CAPTAIN RALPH EARLE was inaugurated sixth president of Worcester Polytechnic Institute on October 22. Rear Admiral William V. Pratt, U. S. N., was the principal speaker.

NEW appointments at Stanford University include those of Dr. Gilbert Morgan Smith, of the University of Wisconsin, to become professor of botany, and Dr. Charles Vincent Taylor, of the University of California, associate professor of biology.

DR. EMILE HOLMAN, associate professor of surgery in the school of medicine of Western Reserve University, has been appointed to the position of associate professor of surgery at Stanford University.

DR. W. J. M. SCOTT, instructor in surgery in the school of medicine of Western Reserve University, is leaving to take the position of assistant professor of surgery in the new Rochester University Medical School on January 1, 1926.

DR. MAXWELL J. DORSEY, head of the department of pomology at West Virginia University, has gone

to the University of Illinois to be professor of pomology and chief of the department there.

APPOINTMENTS have been made to the directing board of the Buenos Aires Medical School as follows: Drs. Castex, Tamini, Speroni, Acuna and Elizalde, by the professors; Drs. Ivanissevich and Usolenghi, by the students.

DISCUSSION AND CORRESPONDENCE

PHOTOGRAPHY OF SHADOW BANDS

As numerous inquiries and press notices have appeared concerning the photography of shadow bands at the eclipse of January 24, 1925, some statement as to the method employed at Middletown by the members of our party may be of interest to readers of SCIENCE.

The success of the undertaking was due primarily to the special method and camera devised and provided by Professor A. E. Douglass, of the University of Arizona, at whose instigation this part of the program was carried out.

The camera consisted of a 13-inch concave mirror and film carrier with focal plane shutter so placed as to operate about six inches outside the focus. The mirror was directed to the sun and a series of exposures made on the out-of-focus image of the slender crescent for a few minutes before and immediately following totality. The method is identical to that used by Professor Douglass in the photography of artificial shadow bands as explained by him at the Washington meeting of the American Association, December, 1924, but so far as known has never before been used at any previous total eclipse.

The most satisfactory exposure was made about five seconds from totality. It shows the bands as atmospheric Schlieren sufficiently distinct for enlargement and reproduction. Measures of the photograph when reduced give for the distance between adjacent bands 2.5 inches, in close agreement with estimates from visual observations. The camera was set up and operated by Mr. D. W. Mann, mechanician at the Jefferson Physical Laboratory, to whose skill much credit is due.

It is of further interest to remark that in contrast to the conspicuous display of shadow bands at Middletown, Conn., Mr. R. F. Field, of the Department of Physics at Harvard, reported no shadow bands whatever visible in open country some twenty miles south of Providence, R. I. This emphasizes the local and atmospheric character of the phenomenon which so far as is known has eluded all attempts at photography until the last eclipse.

HARLAN TRUE STETSON
STUDENTS' ASTRONOMICAL LABORATORY,
HARVARD UNIVERSITY

SMITHSONIAN WEATHER FORECASTS

IN SCIENCE for October 2, 1925, Dr. C. G. Abbot, acting secretary of the Smithsonian Institution, comments adversely concerning a recent review of Smithsonian Publications on "Forecasting Weather." Dr. Abbot says three papers were reviewed; but he is in error, for four papers were included and their titles and serial numbers given. He enters a disclaimer regarding long-range forecasts, adding that "no person connected in any way with the Smithsonian has ventured any such excessively long-range forecasts or knows of any method of making them." It was far from the reviewer's mind to discredit work done by Abbot and Clayton, and I am sorry if injustice has been done to these gentlemen through any text of mine. During the spring and summer, however, we received forecasts from a high official source in New York and were told and our informant so believed that these were forecasts of the weather for New York City, based upon Smithsonian work. Dr. Abbot has stated that for more than a year "definite forecasts of New York temperatures, three, four and five days in advance; average weekly temperature departures forecast two days before the beginning of each; and average monthly temperature departures forecasts two days before the beginning of each month" were made and forwarded daily to the Smithsonian Institution. Our mistake was natural.

His chief objection to the review, however, is that in work of this nature there should be no humor. In my opinion he is unduly sensitive and has taken certain pleasantries about the "unhappy lot of the forecaster" (the heading of the article to which he objects) as applicable to himself. It was not so meant. For example, in speaking of a state of mind bordering on what the Scotch call "feckless indecision" we mentioned that a peace-loving community had served up to them recently the following official forecast:

WEEK-END FORECAST FOR E. AND S. E. ENGLAND.—*Indications are now less definite for unsettled weather though they are not yet definitely favorable for settled fair weather.*

Now it was the people of London, not the citizens of Washington, who had to bear up under this infliction. Surely Dr. Abbot will permit us to see the humor of the situation.

There is an old, old story, which I may be forgiven for repeating here, of the New England farmer who returned from a visit to Boston and proudly showed his wife a barometer. "Well, what good is it,

Hiram?" said the old lady. "Why, now I can tell when it is going to rain!" "Hiram," said she, "I am truly ashamed of you. What do you suppose the good Lord gave you your rheumatism for?"

Aerographers are in a way like the old lady. We would like to ask the Smithsonian investigators "What do they think the good Lord gave us an atmosphere for?" This great thermal engine, so well described by Sir Napier Shaw in his last paper on "The physical structure of the atmosphere." Are we no longer to study from a dynamical point of view the transfer and transformation of energy? The work of years on the convergence of air streams, the development of areas of turbulence and discontinuity—is all this to be relegated to the rear and an undetermined variation in the value of the solar constant of radiation outside the atmosphere to be given first place in forecasting weather?

Dr. Abbot tactfully omitted reference to the serious side of the review, which was to the effect that the results given in the publications seemed to the reviewer to have no substantial basis as factors of value in forecasting. The results negative the claims made.

Dr. Abbot says that perhaps I failed "to see the forest because it was obscured by the trees." Oh! well! I was not looking for forests or even trees, only searching with wistful eye for some sign of vegetation in a dry and thirsty land.

ALEXANDER MCADIE

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AN APPEAL FOR SIMPLIFIED LITERATURE CITATIONS

THE average editor and the average publisher of scientific literature is ultra-conservative with respect to the form of reference citations, whether these be in terminal bibliographies, footnotes or text references to places of publication of technical names. This same statement may also apply equally well to the average author of scientific papers; although usually the author has no choice, being obliged to follow established usages no matter how antiquated and cumbersome these may be, in order to conform to editorial mandates. Forms adopted many years ago are currently followed and in many cases little or no attention is given to utility or to simplification. In some scientific periodicals, the use of the cumbersome Roman numerals for indicating volume numbers has been abandoned, but in a very high percentage of modern periodicals, including a number of recently established ones, this ancient form is still used. It may be doubted if editors, publishers or authors give much attention to these seemingly small details, being more apt to follow the line of least resistance and past or current usage.

The conciseness, clearness and utility of indicating the volume number by black-faced figures **38** as compared with the Roman characters XXXVIII is manifest. With the use of the black-faced figures it is not necessary to stop to translate, as is frequently the case when the cumbersome Roman system is used. We are all more or less familiar with the lower numbers in the Roman series from long usage, but few can rapidly translate the more complicated higher figures. In this age of rapid publication shall we go to the extreme, when called upon to cite such a publication as Bulletin **1348** of the U. S. Department of Agriculture by translating the simple figures into the cumbersome MCCCXLVIII? In a larger number of modern serial publications this absurd procedure becomes necessary because of usage and established editorial custom and is pedantic in the extreme.

There is little uniformity in scientific literature in reference to the form of citation. It not infrequently happens that an author in preparing a paper for submission to a certain journal follows the form approved for that serial, but if he changes his mind and later desires to submit the paper to some other serial, he frequently has to rewrite considerable parts of the manuscript in order to bring it into conformity with the style followed in the second one. This is especially true if the paper happens to be a taxonomic one with numerous literature citations or one with an extensive bibliography.

In several modern standard review publications the conciseness and utility of the simplified form of citation has been amply demonstrated, but editorial usage in review publications has had little or no influence on the forms used in established technical periodicals, while the editorial staffs of newly established serials frequently give no consideration to the matter. We are all familiar with review literature, but most of us are impervious to the manifest advantages of the simplified citation forms adopted by the majority of them. The simplified form adopted by several standard review publications is given below:

Chemical Abstracts: 24, 57–70 (1925).
Science Abstracts: (—24. pp. 57–70, Feb., 1925).
Botanisches Centralblatt: 1925, 24, 57–70.
Botanical Abstracts: 24: 57–70. 1925.

In order to indicate the wide range of variation in reference citation, even where the Roman system of indicating volume numbers is not used, the following data have been compiled from the same reference in four different periodicals:

	Number of Characters
(1) *Experiment Station Record:* (Ann. Appl. Biol., 24 (1923), No. 2, pp. 151–193, pls. 3, figs. 31).	56
(2) *Journal of Agricultural Research: In* Ann. Appl. Biol. v. 24, 1923, p. 151–193, pl. 1–3, fig. 1–31.	52
(3) *Philippine Journal of Science:* Ann. Appl. Biol. 24 (1923) 151–193, *p. 1–3, fig. 1–31.*	45
(4) *Botanical Abstracts:* Ann. Appl. Biol. 24: 151–193. *3 pl. 31 fig.* 1923 [or *pl. 1–3, fig. 1–31.* 1923].	40–46

In No. 1, with 56 characters, no data except the irrelevant "No. 2" are given that are not included in the shortest form utilizing but 40 characters. Two pairs of parentheses, "No. 2," "pp." and several commas are redundant. There is no differentiation in type; that is, nothing to catch the eye.

In No. 2, with 52 characters, the following are redundant: "In," "p," "v" and several commas. There is no differentiation in type.

In No. 3, with 45 characters, the parenthesis is redundant, owing to the place of the date of publication. There is, however, proper differentiation of type as to volume, plates and figures.

In No. 4, with 40 characters in its simplest form, there are no redundant letters, figures or punctuation marks, the latter being reduced to a single colon and several periods. The volume number, page, plate and figure references are properly differentiated. Nothing essential is left out. It is the easiest to read and to proof read; the easiest to write, whether long hand or on the typewriter; and what is still more important presents a minimum chance of error. These points are perhaps matters of slight importance in short papers having only a few references but become of very great importance in those works having hundreds and even thousands of references.

There is little force in the argument that type of different styles such as black face, Roman and italics should be avoided in the same line. Most modern composition work is done on the linotype or monotype machine and with these machines the use of different fonts is practically as simple from the standpoint of the compositor as it is for a copyist to operate the shift key on a typewriter for upper case characters.

Merely because an established form of citation has been followed for many years is no reason why a change should not be made, especially if the change still makes the reference entirely clear and eliminates useless characters. Utility, simplicity, clarity and brevity should be the criteria, not past or current custom. The general adoption of the concise form utilized in *Botanical Abstracts* by publishers, by responsible editors of technical literature and by authors of technical papers is greatly to be desired.

This appeal for the simplified form of citation is primarily directed to publishers, editors and members of editorial staffs. Unless the initiative be taken by these, the individual author is powerless in the matter. Scientists are frequently accused of not being practical, but here is an opportunity of demonstrating on a small scale a distinctly time-saving device that would in the long run make our published data simpler, clearer and more attractive. I venture the prediction that no author who has once prepared a paper in which the simplified form of citation herein discussed is used will voluntarily revert to the more ancient complicated forms that still prevail in the majority of our technical publications, whether these be in serial form or individual volumes.

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THE EFFECT OF MINERAL SUPPLEMENTS ON REPRODUCTION OF THE ALBINO RAT

FAILURE of growth in the second generation of rats on a ration of corn and peanut meal supplemented with acid phosphate was reported last year.[1] The basal ration was later fortified with dried meat and cod liver oil. When the improved ration, consisting of white corn 30, wheat 30, peanut meal 25, dried meat 12, and cod liver oil 3, was supplemented with 1.0 per cent. of NaCl and 1.5 per cent. of acid phosphate, reproduction was not more successful than on the acid phosphate ration in the former experiments. The females on this ration farrowed normal numbers of young; but they apparently furnished very little milk and the pups soon became thin and scrawny. Many of the pups were eaten by the dams. None of the litters reached the age of weaning.

The addition of sufficient $NaHCO_3$ (0.5 per cent. of the total ration) to neutralize the excess of H_2SO_4 carried by the phosphate resulted in marked improvement. We now have young rats, representing the third generation on this ration, that are being raised successfully.

Other investigators have shown that the pig, goat, cow, rabbit and monkey are able to combine ingested mineral acids with ammonia and excrete the ammonium salts through the urine. Some of their experiments have shown that protein storage on a normal level of protein intake or growth through a considerable period of time was not interfered with. It has not been shown, however, that normal repro-

[1] Salmon, SCIENCE, 60, 457, 1924.

duction occurs under conditions of prolonged ingestion of mineral acids.

Our observations show that a small amount of H_2SO_4 may limit the growth of the rat in the second generation even when little or no effect on the growth of the first generation was apparent.

A study of the effect of various acids and acid-forming substances on the reproduction of rats and swine is now being made in this laboratory.

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THE HYDROID OF CRASPEDACUSTA RYDERI IN KENTUCKY

SINCE the finding of the hydroid of Craspedacusta ryderi[1] (1920) in Boss Lake, Elkhart, Indiana, I have been anxious to find it elsewhere, especially so since all the medusae at Elkhart were females and all medusae found elsewhere were males. I have been interested in the sex question involved and wish to transplant hydroids from some other source to Boss Lake.

July 30 I made a trip to Benson Creek, where Garman[2] found the medusae in 1916, 1917 and in 1924, and was rewarded by finding the hydroids on the rocks in the shallow water just above the place where the medusae were most abundant. As the water was muddy and most of the rocks covered with slime only a few hydroids were found. Some of these I took to my laboratory, where they now are and where I hope to be able to rear them. When the water clears I shall try to find more of them.

In comparison with the hydroids in Boss Lake they are much smaller, but otherwise they look the same. The size difference may be merely a question of the food supply. The water in the creek contained very few micro-organisms.

The hydroids were not producing hydroid or medusae buds. This would also indicate unfavorable conditions.[3]

FERNANDUS PAYNE

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SCIENTIFIC BOOKS

The First One Hundred Years of American Geology. By GEORGE P. MERRILL, head curator of geology, United States National Museum. XXI + 773 pages, 6½ x 10 inches. Yale University Press. 1924.

IN the report of the U. S. National Museum for 1904 Dr. Merrill published "Contributions to the history of American geology," a work of great and timely interest. The present volume is practically a republication of the former work, with the addition of three new chapters on special subjects and an appendix of personal letters. It makes a handsome large octavo volume of 773 pages, with 36 page plates and 130 text illustrations. The illustrations are slightly less in number than in the former volume. Twenty of the plates and 105 of the text figures are portraits. This is the first work published on the Philip Hamilton McMillan Memorial Publication Fund.

The history covers the ten decades from 1785 to 1885, grouped in eight eras. The first two eras are named after the two most active workers in the early days, William Maclure, the "father of American geology," and Amos Eaton, the earliest teacher of the science. The Maclurean Era includes the years 1785–1819, and the Eatonian 1820–1830. Five chapters cover five decades of State Geological Surveys (1830–1888), with chapter eight devoted to the National Surveys. The special problems discussed in the previous work were, "The fossil footprints of the Connecticut Valley," "The Eozöon question," "The Laramie question" and "The Taconic question." The three new special topics are, "The development of the glacial hypothesis"; "The development of micro-petrology," and "How old is it?"

The biographical sketches of the geologists are not the least interesting part of the history, and the author has described the workers and their work with discrimination and fairness. The appended personal correspondence is a welcome addition. It also emphasizes the large psychologic element, especially in the pioneer work. Geology is not an exact science, but relies on observation, diagnosis, comparison and interpretation. The personal element in the early years is shown by the diverse and even contradictory views on phenomena and features which to-day are lucid. A touch of humor is suggested by the placing of the portraits of Cope and Marsh side by side.

The student of geology finds the history a real romance. The young worker especially needs it for breadth of information and as suggestion of caution in his work and modesty in opinion. Dr. Merrill has done a good service not only to the geologic profession but to general science, and to the history of the evolution of real knowledge. It was a rare and fortunate combination for the author to have access to the literature and records, the time, patience and industry for collecting the vast mass of fact and the knowledge and discrimination necessary for its effective presentation.

The only suggested criticism of the work is its

[1] Payne, *Journ. Morph.*, Vol. 38.

[2] Garman, SCIENCE, Vols. 44, 56 and 60.

[3] Three weeks later hydroids were found in abundance and transplanted to Elkhart.

omission of the history since 1885. Four decades have passed, and two decades since the first publication of the work. It would appear that the progress in the science up to at least 1900 might have been given with sufficient perspective and with justice to the few surviving men. They would not be injured by a little praise while living. Such later account would be helpful especially to younger workers in the field.

H. L. F.

SPECIAL ARTICLES

THE CHEMICAL EFFECTS IN IONIZED ORGANIC GASES

ABOUT a year ago[1] we gave a preliminary account of the effect of ionizing pure ethane by means of radon (radium emanation) mixed with it. This work has since been extended, and a further preliminary report will now be made. The gases hitherto studied are methane, ethane, propane, butane, ethylene, acetylene, cyanogen, hydrogen cyanide and ammonia; other reactions studied are: oxidation of all the foregoing except ethylene and hydrogen cyanide; the hydrogenation of acetylene, ethlene and cyanogen, and the polymerization (also in the presence of nitrogen) of acetylene, of cyanogen and of hydrogen cyanide.

In methane, propane and butane the same kind of behavior was encountered as for pure ethane. The idea has been abandoned (also for ethane) that free carbon results from these reactions. In fact, it is more exact to use the term condensation (with elimination of hydrogen) instead of decomposition. The yellow or brownish color of the liquid or solid condensates we now attribute to some unsaturation, not to free carbon.

In the case of methane the pressure change at room temperature is not a safe criterion of reaction, for the pressure remains almost constant, even when analysis shows that the greater part of the gaseous product is free hydrogen which is accounted for by reaction without volume change, such as:

$$2CH_4 = H_2 + C_2H_6.$$

The condensation of a liquid from methane is much delayed, perhaps, because it must build up in successive steps from the lowest member, methane. In propane and in butane liquid appears in droplets much sooner even than in ethane, and later may pass partly into the solid state, if a sufficient quantity of radiation be absorbed by the liquid. The phenomena in propane contained in a small volume where the density of radiation at the wall was high were particularly striking; minute gelatin-like masses with sharply defined contours built up to an appreciable depth on the wall and later curled away from it; while in a larger volume with a lower radiation density only liquid appeared. In radiating methane the total pressure at 25° C. remained practically constant during the entire reaction.

In the earlier paper it was suggested that the liquid phase formed from ethane might be octane. We now know that the ratio of hydrogen to carbon in the liquid condensates is about 1.8 to 1, which would indicate some degree of unsaturation or ring compounds, or both. Analysis further shows that methane as well as hydrogen is a product of the condensation of ethane, of propane and of butane; the ratio of hydrogen to methane liberated remained constant throughout the reactions and had the following values: for ethane about 6 hydrogen to 1 methane, for propane about 4 to 1, for butane about 6 to 1. Small proportions of other saturated hydrocarbons are also found, *e.g.*, propane and butane in the ratio of 1 to 2 from ethane; and ethane and butane in the ratio of 4 to 5 from propane. Evidently, if either one hydrogen or one methane molecule can be eliminated from a di-polymer of ethane (as assumed in our former paper) the residues would be butane and propane, respectively, and so forth for other similar possibilities. If two hydrogen molecules be eliminated from the di-polymer of a saturate, unsaturation would result, as illustrated by the ratio found, 1 carbon to 1.8 hydrogen (approximately the same in the liquids from ethane, propane and butane). Probably the two reactions involving the elimination of one or of two hydrogen molecules proceed simultaneously. Evidently, by this means, starting with any saturated hydro-carbon we can get both lower and higher members until soon all the members up to quite high polymers will be represented in the mixture, thus suggesting the mixtures occurring in petroleum.

In these ionic condensations of saturated hydrocarbons the average number of molecules of hydrocarbon condensing per positive hydrocarbon ion, M/N, varies from 1.4 to 2. For the unsaturated hydrocarbons M/N is higher, for ethylene (double bond) about 5, for triple bond compounds yet higher—cyanogen, 7; hydrogen cyanide, 10; acetylene, 20,[2] the highest yet found. This shows that the ionic

[1] SCIENCE, 60, 364, October, 1924.

[2] Professor W. Mund, of the University of Louvain, kindly communicated this value for acetylene (which we have confirmed) in advance of a forthcoming publication (*Bull.* Soc. Chem. Belg., 34, 241, May, 1925), the appearance of which has been delayed by a printers' strike in Belgium. We have also confirmed in general the results reported by Mund and Koch (*ibid.*, 34, 119, February, 1925) on the radiation of ethane, ethylene and acetylene.

clusters are larger for the double and triple bond compounds than for the saturated ones.

Cyanogen yielded a brownish to black solid resembling paracyanogen; a little nitrogen (about 5 per cent.) was liberated during the polymerization. Hydrogen cyanide gave a reddish to brown solid, which by analogy may be called "parahydrocyanic acid," while liberating about 5 per cent of permanent gas (which a preliminary analysis showed to be nitrogen). Ethylene yielded a liquid and quite a large volume of free hydrogen, as reported by Mund and Koch (*loc. cit.*) with possibly some methane. Acetylene yielded with small evolution of hydrogen (about 2 per cent. of the initial volume of acetylene) a yellow (white in the earliest stages) solid powder similar to "cuprene"[3] —also in agreement with Mund and Koch.

The oxidation of methane and of ethane proceeds completely to carbon dioxide and water at a rate satisfying the general kinetic equation previously developed for hydrogen oxidation, which is also applicable to carbon monoxide oxidation, and to many other reactions. The principle of the *exclusivity of oxidation* exhibited in the oxidation of carbon monoxide by oxygen (*J. A. C. S.*, Nov., 1925) applies strikingly to both methane and ethane; *e.g.* methane in the presence of oxygen does not liberate hydrogen as it does alone, and ethane neither liberates hydrogen, nor does liquid phase appear, except water which is easily distinguished (by appearance and freezing point) from the oily liquid droplets due to its condensation to form liquid hydrocarbons. The value for methane oxidation of $\frac{M(CH_4 + O_2)}{N(CH_4 + O_2)}$ is 4.4, but in the presence of 1 molar per cent. of $Se(C_2H_5)_2$ attained a value of 5.7, only slightly below the value 6, obtained for carbon monoxide. The value for ethane $\frac{M(C_2H_6 + O_2)}{N(C_2H_6 + O_2)} = 7$, is also somewhat lower than the theoretical 9.0. The oxidation of propane is not complete to carbon dioxide and water in the earlier stages of the reaction; less oxygen disappears than required; oily droplets appear indicating partial oxidation products. This becomes yet more pronounced for butane oxidation; much less oxygen disappears per butane molecule than would correspond to complete oxidation; water and oily droplets appear and the carbon dioxide formation represents but a small part of the carbon leaving the gas phase.

The other cases of oxidation which have been studied include that of cyanogen and of acetylene. In both cases exclusively of oxidation is most striking. Acetylene gives a clear colorless liquid and none of the yellow powder (as it does alone); it combines with oxygen in a 1 to 1 ratio; little or no carbon dioxide is formed (except by secondary action upon the product on the wall). The oxidation product is one of direct addition (a polymer of CHO) which we have not identified. The ratio $\frac{M(C_2H_2 + O_2)}{N(C_2H_2 + O_2)}$ is not less than 16 and may be as high as 20, the value for acetylene alone. The oxidation of cyanogen gives exclusively a white powder (instead of the black polymer obtained from pure cyanogen) which is an addition product of the formula $(CNO)_x$, not described in the literature. Its properties have not yet been studied. The ratio $\frac{M(C_2N_2 + O_2)}{N(C_2N_2 + O_2)}$ is approximately 7, the same as for the polymerization of cyanogen, but some gaseous nitrogen and carbon dioxide are formed as the result of a split reaction. Recently we have effected the hydrogenation of acetylene and of cyanogen. The reactions are not exclusive, thus showing a marked difference from the case of oxidation, by which is meant that besides that part of the reaction which resulted in the addition of hydrogen to the unsaturated compounds, polymerization of the latter also occurred in a parallel reaction. This result had been anticipated from the general theory of the exclusivity of oxidation.

The addition of nitrogen to acetylene was attempted in a 1 to 1 mixture. No combination with nitrogen was effected. The only reaction was that of the polymerization of acetylene to give the same yellow product obtained from acetylene alone. However, it was found that although nitrogen does not react itself, its presence much enhances the rate of acetylene polymerization; the relative rate continuing to increase owing to the increasing ratio of N_2/C_2H_2 as the reaction proceeds. This is a new kind of catalysis which may be called *ionic catalysis*. It is the more striking since it was not observed in the previous cases studied. The presence of a gas which itself did not permanently enter into reaction, we had hitherto found to have no influence on the rate of reaction. For example, the accumulation of carbon dioxide does not accelerate the rate of oxidation of carbon monoxide, nor of methane, etc.; nor does nitrogen enhance the rate of decomposition of ammonia. The function of nitrogen in catalyzing the polymerization of acetylene is to furnish additional clustering and polymerizing centers in the form of N_2^+ ions. We have just found that the number of acetylene molecules condensing for each N_2^+ ion is approximately 20, the same as for each $C_2H_2^+$, and that polymerization by both routes proceeds simultaneously. In other words

[3] Sabatier and Sanderens, Comp. rend., 130, 250 (1900); H. Alexander, *Ber. deut. Chem. Ges.*, 32, 2381 (1899).

$\frac{-M(C_2H_2)}{N(C_2H_2+N_2)} = 20$. We have also found N_2^+ ions to have a like influence in the polymerization of cyanogen and of hydrogen cyanide where again the values $\frac{M(C_2N_2)}{M(C_2N_2+N_2)} = 7$ and $\frac{M(HCN)}{N(HCN+N_2)} = 10$ are practically identified with those reported above for cyanogen and hydrogen cyanide alone. This new type of catalysis in the gas phase will be more fully considered in a subsequent paper.

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MORPHOLOGICAL CHANGES IN BACTERIUM TUMEFACIENS

IN determining the location of the organism, Bacterium tumefaciens, in the crown gall disease, it has seemed desirable to study daily fixations of tissues inoculated, together with smears of the bacteria from similar cultures used for the inoculation. These studies were made daily for a period of seventy-two days for twelve subcultures.

While I am not ready to report my observations on the tissues studied nor to give in detail my study of the smears examined, I believed there is one point of sufficient interest to students of bacteria, pathogenic to plants and animals to warrant this preliminary statement.

A smear of a bean agar culture of Bacterium tumefaciens three months old carefully prepared and stained with Loeffler's methylene blue shows an amorphous mass of jelly-like substance with occasional deeply stained minute spherical bodies. On transferring a needle full of this material to a fresh bean agar media a pearly white growth appears two days later about the streak or point of inoculation. A smear of this young culture shows long rods which not infrequently present a beaded appearance. These bacilli are apparently in the stage Henrici[1] refers to as "embryonic."

The culture grows very rapidly and under favorable conditions covers an area of one and one half cm in diameter in three to five days. Bacteria from the old and young cultures tested separately on young geranium plants were found to produce the crown gall disease equally well.[2]

Daily smears made with care to avoid contamination show that the rods break up and become smaller and smaller as the age of the culture increases until after twenty days or less when the rods are replaced by small faintly staining cocci with occasional slender bacilli or filaments. The zoogleal mass generally present appears to increase with the increasing age of the culture. The cocci also seem to disappear and the entire field resembles the picture first described. Studies of transfers have been made a great number of times with the same results.

In a large number of my subcultures which were studied separately an abundance of small lenticular bodies appear which are about equal in length but a little wider than the Bacterium tumefaciens rod. Both ends of this body stain deeply with a large variety of stains. The center portion of the body is hyaline and fails to color. These bodies are undoubtedly spores. When transferred to fresh media they germinate and give rise to a rod-like body not unlike Bacterium tumefaciens in size. In old cultures these spores appear to lose their ability to stain, but may be recognized as the body most abundant in the smear. I have tried to use these spores as a guide in locating the rods of Bacterium tumefaciens in the host. Unfortunately they also appear to be lost in old overgrowths. While I am not prepared to state definitely at this time that these spores form another phase in the life of Bacterium tumefaciens, they do not interfere with the development of the crown gall disease. Smith[3] states definitely that no spores are formed by Bacterium tumefaciens.

These observations may, in a measure, explain the difficulty associated with locating the causative organism in old crown gall tissue. It appears that Löhnis's[4] studies on the life cycle of bacteria find support in my observations of Bacterium tumefaciens. It is quite possible that the various sizes ascribed to Bacterium tumefaciens by Smith, Robinson and Walkden,[5] and Riker,[6] may be due to the fact that the age of the culture studied by these authors was not taken into consideration. The cultures of bacteria I have been studying principally are Smith's hop strain of Bacterium tumefaciens.

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[1] Henrici, A. T., SCIENCE, N. S. 61, No. 1591, 644–647, 1925.

[2] Levine, Michael, *Bull. Torrey Bot. Club*, 50: 231–243, 1923.

[3] Smith, E. F., Brown, A. N., and L. McCullock, U. S. Dept. Agr. Bur. Pl. Ind. Bull. 255, 160, pls. 109, 1912.

[4] Löhnis, F., Mem. Nat. Acad. Science, 16, 1921.

[5] Robinson, W., and Walkden, H., *Ann. Bot.*, 37, 299–324, pls. 5–6, 1923.

[6] Riker, A. J., *Jour. Agr. Res.*, 25, 119–132, pls. 1–5, 1923.